DEPARTMENT OF TRANSPORTATION SERVICES

CITY AND COUNTY OF HONOLULU

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September 17, 2009

RT9/09-333228

Mr. Mark Kawika McKeague, Chair
Oahu Island Burial Council
Kakuhihewa Building
601 Kamokila Boulevard, Suite 555
Kapolei, Hawaii 96707

Dear Chair McKeague:

Subject: Honolulu High-Capacity Transit Corridor Project

On September 9, 2009, the Honolulu High-Capacity Transit Corridor Project (HHCTCP) staff discussed with the Oahu Island Burial Council (OIBC) potential impacts to burial sites resulting from the construction of an at-grade Light Rail Transit (LRT) system versus the proposed elevated system. HHCTCP staff present at the meeting were Faith Miyamoto, Lawrence Spurgeon, and Art Borst. During the discussion, representatives of the HHCTCP presented descriptions of the effects of at-grade LRT construction. These descriptions were based on modern LRT designs and construction techniques recently used in Phoenix, AZ; Seattle, WA; Portland, OR; Salt Lake City, UT; Denver, CO; St. Louis, MO; Jersey City, NJ; and many other cities in the United States that currently operate modern at-grade LRT systems.

After the discussion between the OIBC and the HHCTCP staff, representatives from two separate groups, the American Institute of Architects (AIA) and Kamehameha Schools (KS), asked to address the OIBC to discuss findings outlined in two reports distributed to the OIBC at this meeting. The HHCTCP staff present did not receive copies of the reports cited during the OIBC discussions and did not have the opportunity to respond due to time constraints. However, they did take note of the points being made to the OIBC.

Both groups made the following assertions to the OIBC:

- At-grade track construction excavation does not have to be deeper than 17 inches and in some places can be as little as 12 inches.
- Over excavation (below 17 inches or 12 inches) to remove "softer" or less compact material under city streets is not needed as heavy traffic on the streets has already consolidated the subgrade material.
- There would be very little impacts to utilities since only 12 inches to 17 inches of excavation is needed.
- Track slabs only need to be eight feet wide for a single track.
- HHCTCP representatives grossly exaggerated the impacts of at-grade LRT excavation/construction.

We believe these points are inaccurate and misrepresent the serious impacts of at-grade LRT construction. Therefore, we feel it necessary to clarify a few issues. Some general clarifications are in order before addressing the specifics of the AIA and KS assertions.

Streetcar systems and LRT systems are different despite many of the visual similarities. A streetcar is a light duty, low capacity, relatively short-distance rail system that is designed as an urban circulator linking destinations within close proximity to each other. It is a comparatively small rail transit vehicle with less capacity than most modern LRT vehicles. Streetcars are not coupled together to form trains, and they function very much like a bus in a non-exclusive right-of-way within an urban environment. A picture of the Portland Streetcar is shown in Figure 1a.

LRT is a higher capacity transit system than streetcars that can operate at-grade as well as above or below ground. Light rail vehicles can operate at higher speeds than streetcars, can be coupled together to form multi-car trains and are designed for applications that can span long distances. LRT has been popular throughout the United States over the past 20 or 30 years as an alternative in many cities that can accommodate at-grade tracks within their transportation network. Light rail vehicles generally weigh more than streetcars and require a more substantial foundation for the tracks. A picture of the Portland MAX light rail system is shown in Figure 1b.

Many of the examples cited in the LRT alternative report provided by Kamehameha Schools are from streetcar systems. As we address the assertions made by the AIA and KS, we will use examples from many modern LRT systems, not the much lower capacity streetcar systems, as these are deemed to be completely inappropriate for addressing the transportation needs of Honolulu.

The following are our responses to those issues raised by representatives of the AIA and Kamehameha Schools:

AIA and KS assert that at-grade track construction excavation does not have to be deeper than 17 inches and in some places can be as little as 12 inches.

The track slabs (the concrete support for the rails) for various at-grade systems do vary between 12 inches (for low capacity streetcar circulators) and 17 to 24 inches for more typical LRT systems. However, the track slab thickness is only for the concrete slab supporting the track and is not the total amount of excavation needed for at-grade track construction. The concrete track slab is only one component of the total support needed for the transit vehicle. The other critical components needed for proper support of the rail bed are:

- An engineered sub-base placed directly below the track slab (generally six to twelve inches thick), and

- Competent natural soils below the sub-base.

Based on this, the minimum amount of excavation required for an urban in-street LRT system is generally approximately two feet, consisting of 17 inches for the track slab plus six inches for the engineered sub-base. Attachment A - "LRT At-Grade Track Construction Details from Various Cities" includes actual track construction details from cities with modern at-grade LRT systems including Phoenix, Seattle, and Jersey City.

The KS study does not disclose the entire impact of their proposal which includes underground power pickup. Along with the excavation for the track bed, additional excavation is needed below the track bed for power distribution to the transit vehicles. While this does not occur along every foot of the track construction, this requires a significant amount of additional excavation below the two feet already discussed to support the track bed.

Figures 2, 3, 4, 5, 6 and 7 are photographs depicting typical construction of very recent at-grade LRT systems in Phoenix and Seattle. As can be seen, excavations greater than two-foot depths are quite common, very necessary and unavoidable.

Also, if the natural soils are not sufficiently stiff to support the track slab and base, then the sub-base thickness needs to be increased or the softer natural soils need to be removed and replaced with stiffer soils. Either way, the depth of excavation increases. There are instances in other urban at-grade LRT systems where, due to the nature of the soils below the transit line, excavations of up to four to five feet deep have been necessary.

AIA and KS assert that over excavation (below 17 inches or 12 inches) to remove "softer" or less compact material in city streets is not needed as heavy traffic on the streets has already consolidated the subgrade material.

Much of the soils below streets in Honolulu (as in many other cities) do include layers of softer material, including Jaucas sand in which Native Hawaiian burials are most often found. The locations of these materials have been documented over the years by many different subsurface investigations and are partly evidenced by the ongoing filling of dips and depressions in pavements. Figure 8 is a general summary, based on many different subsurface investigations along Dillingham Boulevard, through the downtown area and along Kapiolani Boulevard to Ala Moana Center, of where softer soils below streets suggested to support at-grade LRT operations might be encountered. With the exception of the section of Dillingham Boulevard between Puuhale Road and Waiakamilo Road, much of the proposed at-grade alignment has varying amounts of softer materials below the roadways.

Roadway pavement settlement caused by heavy traffic on pavement sections over softer soils can be dealt with by periodic filling or repairing of dips and depressions in the pavement while traffic is detoured to other streets. This is not an option for an urban at-grade rail transit system. If the track settles, the rail services will have to be shut down (there is no detour route) while costly, time consuming repairs are made to re-level the track.

The need for a very competent track bed with minimal soft soils below it becomes even more important because the weight of many of the modern light rail vehicles currently used in most of the recently constructed at-grade LRT systems in the United States is twice that of the heaviest bus currently used in Honolulu.

Based on this, it is quite likely that excavations over the minimum two feet noted above will be needed to achieve a stable track support system.

AIA and KS assert that there would be very little impacts to utilities since only 12 inches to 17 inches of excavation is needed.

As discussed previously, excavations for an at-grade LRT trackway would likely be a minimum of two feet and could be upwards of four feet deep if softer soils need to be removed. This would impact any utility in at least the upper five feet and likely cause it to be relocated. But this is not the only (or even main) reason utilities below at-grade LRT tracks are being relocated in many modern at-grade LRT systems. Utilities such as water supply, power transmission and distribution, communications, storm and sanitary sewers, and other essential utilities, generally require the ability to be periodically inspected, maintained, repaired and replaced. More and more, utility owners are finding it increasingly difficult (and in some instances unsafe for their workers) to continue these functions if their utilities are left below the LRT tracks that have crowded trains running every three to 15 minutes above the utilities. It is now more the norm than the exception for many of these utilities to be relocated than left below the track.

In Honolulu, all of the main arterials that the Kamehameha Schools report recommends as good candidates for at-grade LRT alignments (Dillingham Boulevard, Hotel Street, King Street, Queen Street, Ward Avenue, and Kapiolani Boulevard) contain many of these vital utilities. Figures 9 and 10 illustrate the possible impacts to underground utilities along Dillingham Boulevard and Kapiolani Boulevard should an at-grade LRT system be configured as suggested in the Kamehameha Schools report.

Along Dillingham Boulevard (Figure 9), water, gas, storm drains, and sanitary sewer lines would need to be abandoned from below the LRT track slabs and relocated to an area below the traffic pavement that is clear of any existing utilities. This will require considerable amounts of excavation in the upper ten feet of Dillingham Boulevard. Conditions along Kapiolani Boulevard (Figure 10) would be similar with regard to utility relocations.

AIA and KS assert that track slabs only need to be eight feet wide (for a single track).

Eight-foot wide track slabs have been used for single track slabs for low capacity streetcar circulators in cities such as Portland and Seattle. However, these low capacity streetcar circulator vehicles are only about two-thirds of the weight of modern light rail vehicles. Typical single track slabs used for LRT systems in Seattle, Phoenix, Jersey City, and other cities vary from eight feet wide to 12 feet wide as illustrated in Attachment A. If a twin track LRT system is used, the track slab would be at least 24 feet wide and is generally wider (up to 30 feet wide) to accommodate a safety walk between the tracks and space for the overhead contact system support poles. If the track way is used as a traffic lane for bus traffic, which is often the case, then the track slab is usually 12 feet to 13 feet wide to accommodate bus traffic also.

AIA and KS assert that HHCTCP representatives grossly exaggerated the impacts of at-grade LRT excavation/construction.

All of the above points lead to the following observations regarding at-grade LRT proposed along Dillingham Boulevard from Middle Street and Puuhale Road through downtown Honolulu to Ala Moana Center (approximately 4.5 miles) as described in the "Light Rail Transit Report" provided by Kamehameha Schools:

- **Amount of excavated material and potential impact to burial sites**

The amount of excavated material in the area ten feet below the surface street (the area most likely to contain burial sites) for an at-grade LRT system consisting of two 12-foot wide track slabs with only two feet of excavation is approximately TEN TIMES the amount of material that would be excavated for an elevated transit system with columns spaced between 100 feet and 150 feet apart. Therefore, one might surmise that the odds of disturbing a burial site in the 4.5 miles between Middle Street and Ala Moana Center are ten times greater if an at-grade system is built than if an elevated system is built. It is highly possible that the at-grade track excavation will be deeper than two feet, as it may well be for reasons cited above, resulting in potential impacts to burial sites beyond the ten times amount noted for just two feet of excavation.

- **Impacts on utilities and additional excavation required to relocate utilities otherwise not affected that could affect burial sites**

For an at-grade system with two single track slabs, the minimum "zone" of impacted utilities below the track slabs would be 12 feet X 2 = 24 feet wide. For an elevated transit facility, the foundations would be approximately eight feet in diameter. Allowing four feet on both sides of the foundation as an area within which utilities would need to be relocated if encountered, that "zone" of impacted utilities becomes 16 feet. As illustrated in Figures 9 and 10, considerably more utilities would be impacted and need to be relocated due to at-grade LRT construction than would be anticipated for elevated guideway construction. The additional excavation that would be required for utility relocations would further exacerbate the impact on burial sites.

CONCLUSION:

We are very sensitive to potential impacts to burial sites due to the proposed HHCTCP elevated transit system. We also believe that the impacts of the proposed elevated transit system on burial sites are less than the impacts that would be realized from an at-grade LRT system such as the one described in the "Light Rail Transit Report" prepared for Kamehameha Schools.

Should you have any further questions regarding this matter, please contact Ms. Faith Miyamoto of the Rapid Transit Division at 768-8350. We look forward to our continuing coordination to avoid and minimize impacts to burial sites.

Very truly yours,

Wayne Y. Yoshioka
Director

Enclosures

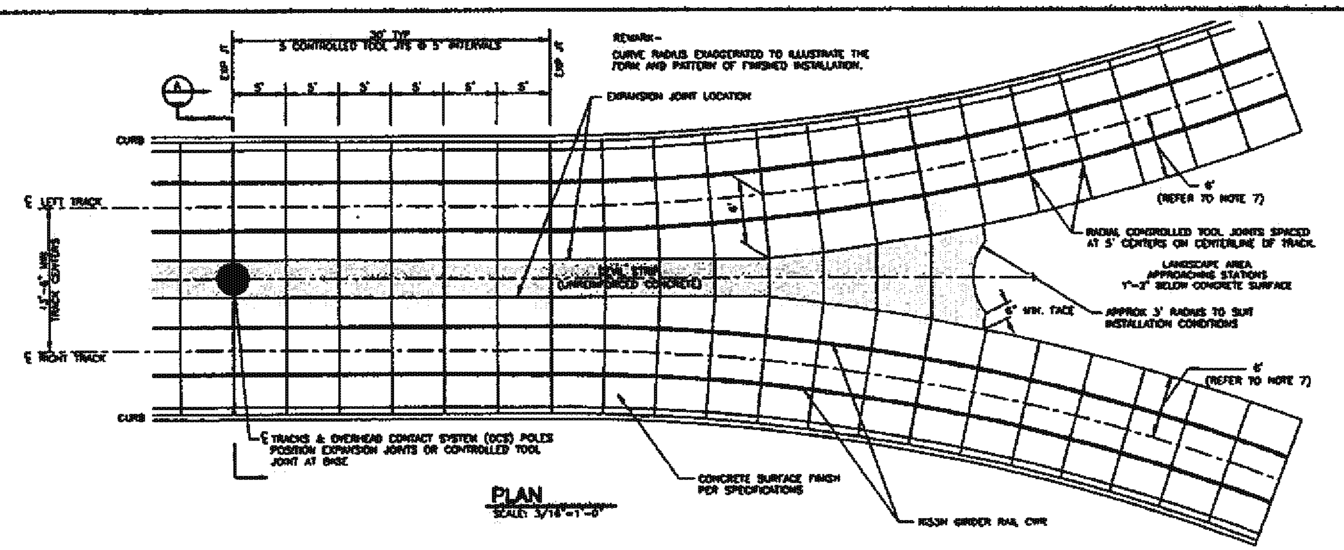
cc: Mr. Kirk W. Caldwell, Managing Director

ATTACHMENT A

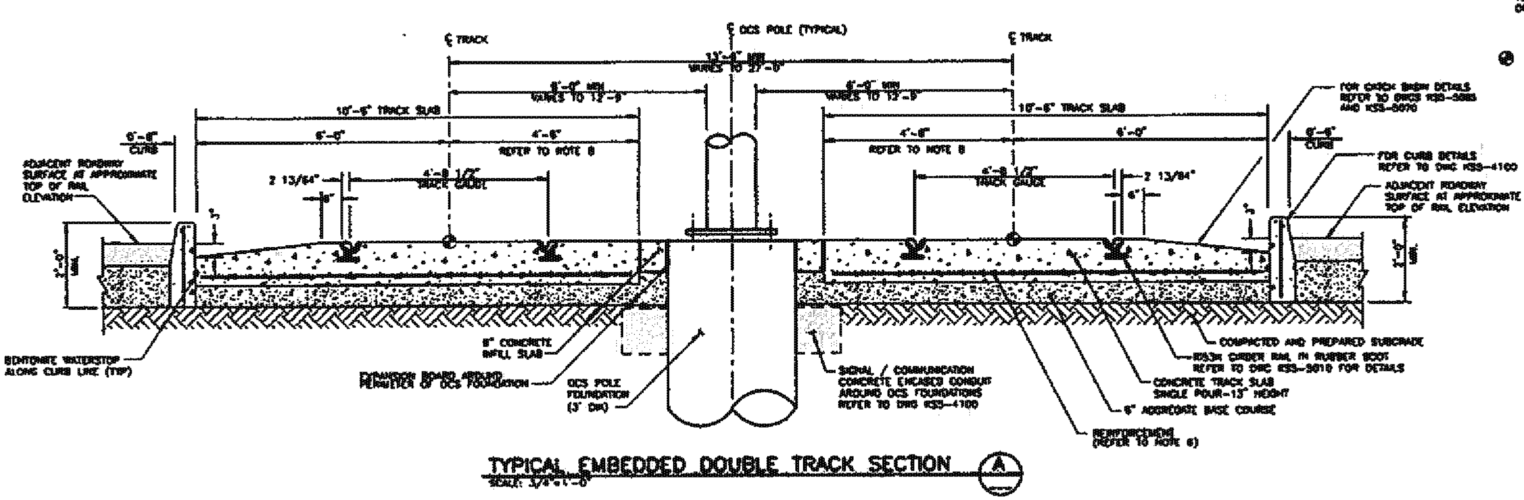
"LRT At-Grade Track Construction Details from Various Transit Systems"

Transit System examples include:

- Valley Metro Rail – Central Phoenix/East Valley LRT
- Sound Transit (Seattle/Tacoma, WA) – Link Light Rail Project
- Los Angeles County Metropolitan Transportation Authority – Eastside LRT
- New Jersey (NJ) Transit – Hudson/Bergen Light Rail Transit system



PLAN
SCALE: 3/16"=1'-0"



TYPICAL EMBEDDED DOUBLE TRACK SECTION (A)
SCALE: 3/4"=1'-0"

NOTES:

1. TYPE E-1 TRACK REPRESENTS THE FIRST TRACK TYPE IN A SERIES OF TRACK TYPES SHOWING THE EMBEDDED TRACK REQUIREMENTS ON THE LRT SYSTEM.
2. FOR LIMITS OF TYPE E-1 TRACK REFER TO TRACK CHARTS.
3. FOR AT-GRADE STREET CROSSINGS, WITHIN THE ABOVE LIMITS, REFER TO TYPE E-2 TRACK ON DWG NO. KS3-3002.
4. FOR DETAILS PERTAINING TO ENDS OF EMBEDDED TRACK REFER TO DWG NO KS3-4031, TRANSITION SLAB EMBEDDED TRACK TO BALLASTED TRACK AND DWG NO KS3-6030, TRANSITION DETAILS DIRECT FIXATION TRACK TO EMBEDDED TRACK.
5. FOR STANDARD RAIL SECTIONS REFER TO DWG NO. KS3-2002.
6. FOR REINFORCED CONCRETE BASE SLAB STRUCTURAL DETAILS & EXPANSION AND CONTROLLED TOOL JOINTS REFER TO STRUCTURAL DRAWINGS KS3-3101 AND KS3-3103.
7. FOR TRACK AREAS WHERE TRACKS WIDEN BEYOND STANDARD DEVIL STRIP WIDTH, WIDEN CONCRETE SLAB FROM 4'-6" TO 6'-0" TO DELINEATE APPROXIMATE DYNAMIC VEHICLE LIMITS.
8. AT CENTER STATION WALKWAY AND PLATFORM AREAS REINFORCED CONCRETE TRACK SLAB TO EXTEND TO EDGE OF WALKWAY AND FACE OF RAMP AND STATION PLATFORM WALL.

(A) INDICATES PROFILE GRADE LINE

CONFORMED

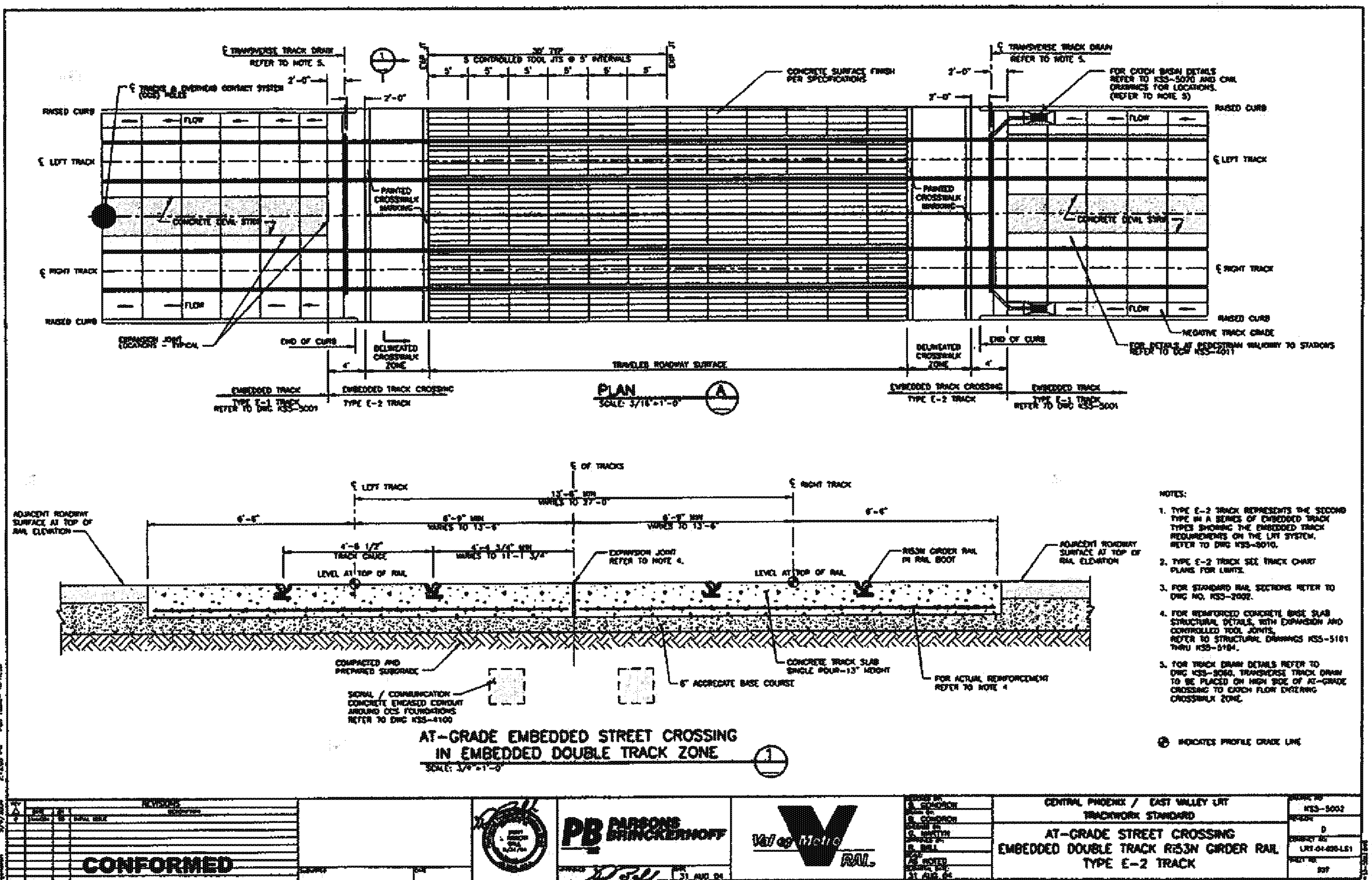
PB PARSONS BRINCKERHOFF

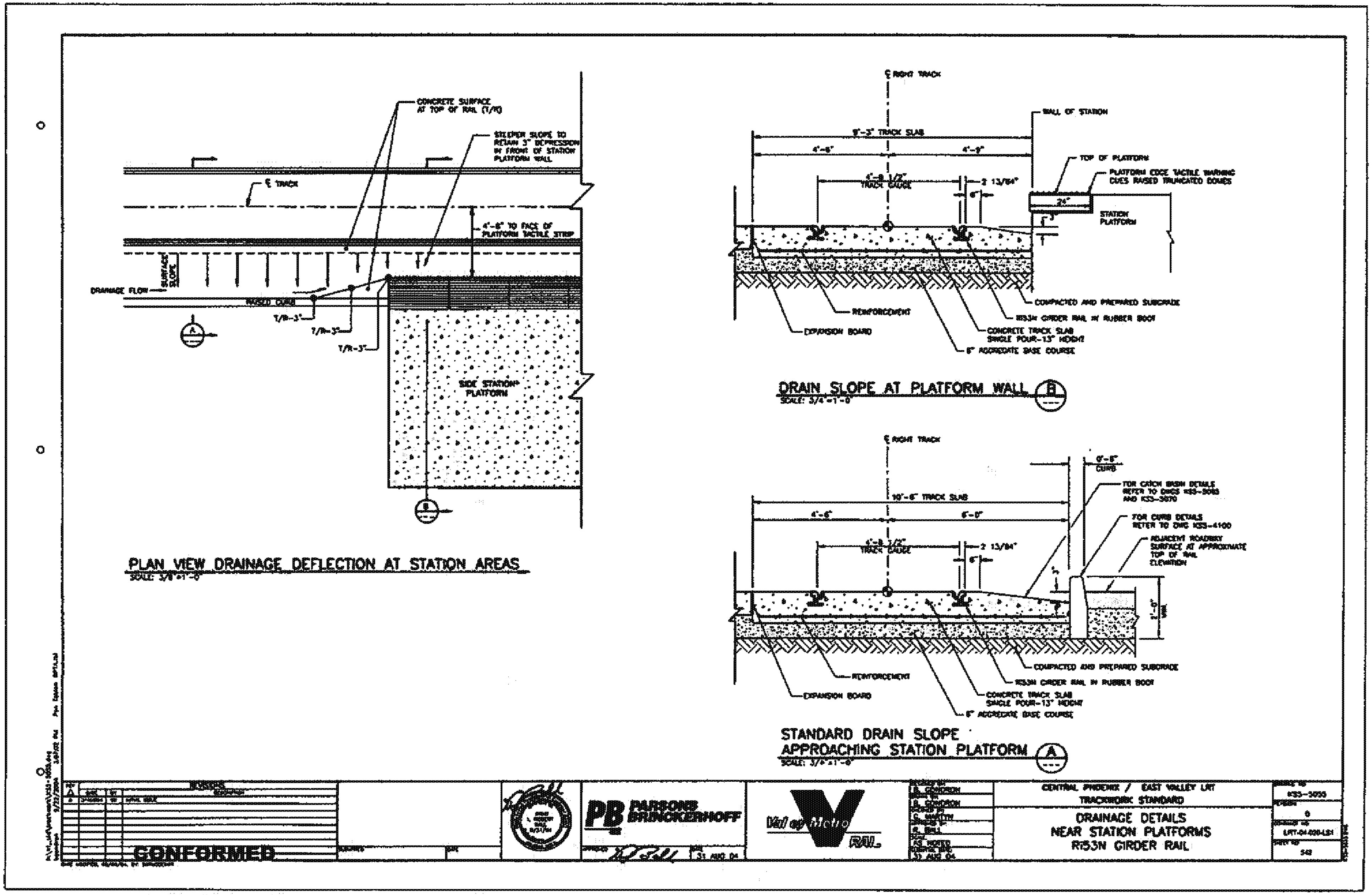
Valley Metro RAIL

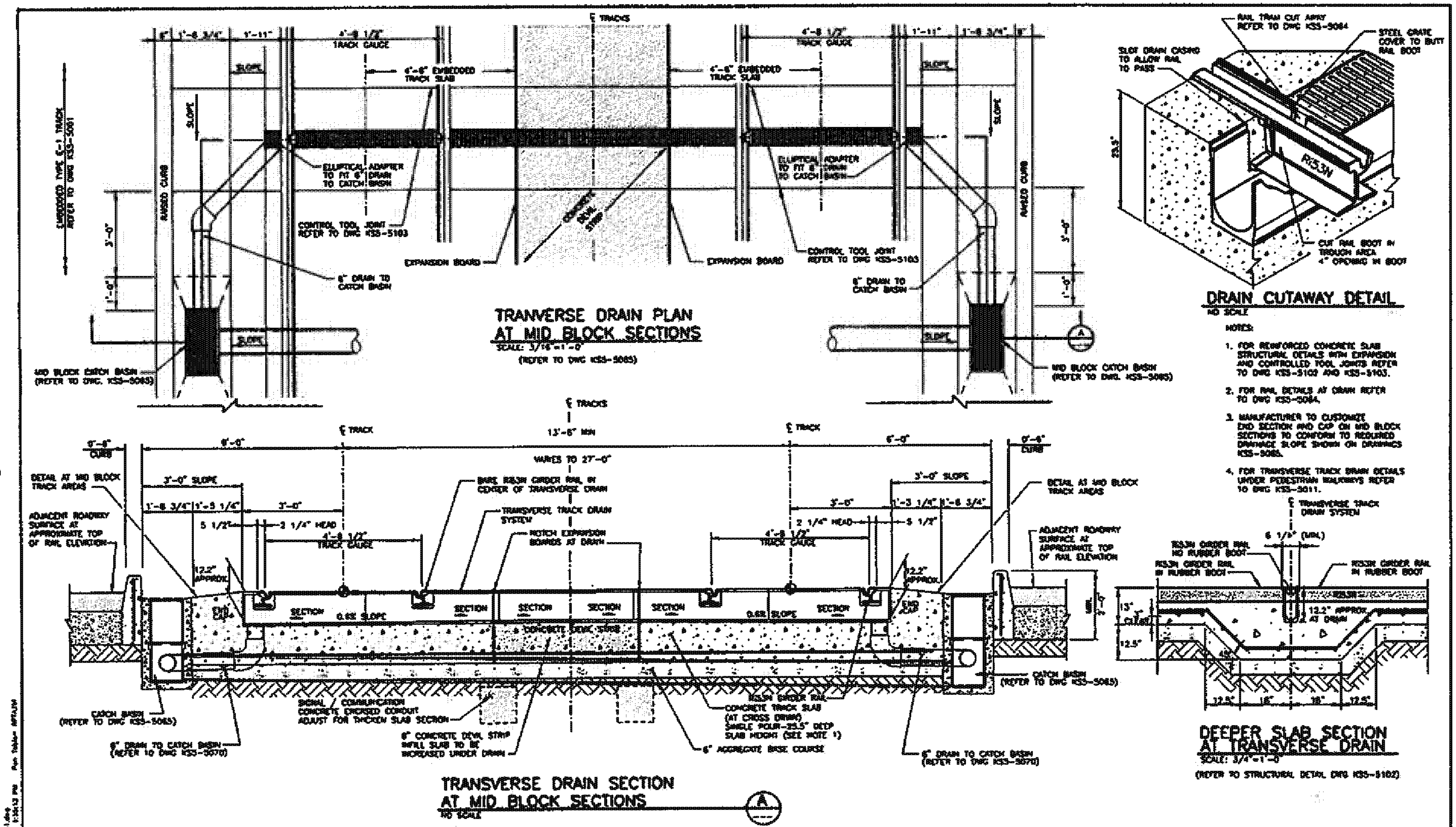
CENTRAL PHOENIX / EAST VALLEY LRT
TRACKWORK STANDARD

EMBEDDED DOUBLE TRACK SECTION
RI53N GIRDER RAIL
TYPE E-1 TRACK

KS3-3001


℄ TRANSVERSE TRACK DRAIN REFER TO NOTE 5.
℄ TRACKS & OVERHEAD CONTACT SYSTEM (OCS) POLES
30' TYP
5 CONTROLLED TOOL JTS @ 5' INTERVALS
5' 5' 5' 5' 5' 5'
CONCRETE SURFACE FINISH PER SPECIFICATIONS
FOR CATCH BASIN DETAILS REFER TO KSS-5070 AND CIVIL DRAWINGS FOR LOCATIONS. (REFER TO NOTE 5)
2'-0"
RAISED CURB
℄ LEFT TRACK
℄ RIGHT TRACK
FLOW
CONCRETE DEVIL STRIP
PAINTED CROSSWALK MARKING
NEGATIVE TRACK GRADE
FOR DETAILS AT PEDESTRIAN WALKWAY TO STATIONS REFER TO DWG KSS-4011
EXPANSION JOINT LOCATIONS - TYPICAL
END OF CURB
DELINEATED CROSSWALK ZONE
4'
TRAVELED ROADWAY SURFACE
EMBEDDED TRACK
TYPE E-1 TRACK REFER TO DWG KSS-5001
EMBEDDED TRACK CROSSING
TYPE E-2 TRACK
PLAN
SCALE: 3/16"=1'-0"
A
℄ OF TRACKS
13'-6" MIN VARIES TO 27'-0"
6'-6"
6'-9" MIN VARIES TO 13'-6"
4'-8 1/2" TRACK GAUGE
4'-4 3/4" MIN VARIES TO 11'-1 3/4"
LEVEL AT TOP OF RAIL
EXPANSION JOINT REFER TO NOTE 4.
RI53N GIRDER RAIL IN RAIL BOOT
ADJACENT ROADWAY SURFACE AT TOP OF RAIL ELEVATION
COMPACTED AND PREPARED SUBGRADE
SIGNAL / COMMUNICATION CONCRETE ENCASED CONDUIT AROUND OCS FOUNDATIONS REFER TO DWG KSS-4100
6" AGGREGATE BASE COURSE
CONCRETE TRACK SLAB SINGLE POUR-13" HEIGHT
FOR ACTUAL REINFORCEMENT REFER TO NOTE 4
AT-GRADE EMBEDDED STREET CROSSING
IN EMBEDDED DOUBLE TRACK ZONE
SCALE: 3/4"=1'-0"
1
NOTES:
1. TYPE E-2 TRACK REPRESENTS THE SECOND TYPE IN A SERIES OF EMBEDDED TRACK TYPES SHOWING THE EMBEDDED TRACK REQUIREMENTS ON THE LRT SYSTEM. REFER TO DWG KSS-5010.
2. TYPE E-2 TRACK SEE TRACK CHART PLANS FOR LIMITS.
3. FOR STANDARD RAIL SECTIONS REFER TO DWG NO. KSS-2002.
4. FOR REINFORCED CONCRETE BASE SLAB STRUCTURAL DETAILS, WITH EXPANSION AND CONTROLLED TOOL JOINTS, REFER TO STRUCTURAL DRAWINGS KSS-5101 THRU KSS-5104.
5. FOR TRACK DRAIN DETAILS REFER TO DWG KSS-5060. TRANSVERSE TRACK DRAIN TO BE PLACED ON HIGH SIDE OF AT-GRADE CROSSING TO CATCH FLOW ENTERING CROSSWALK ZONE.
INDICATES PROFILE GRADE LINE
REVISIONS
FINAL ISSUE
CONFORMED
PB PARSONS BRINCKERHOFF
Valley Metro RAIL
CENTRAL PHOENIX / EAST VALLEY LRT
TRACKWORK STANDARD
AT-GRADE STREET CROSSING
EMBEDDED DOUBLE TRACK RI53N GIRDER RAIL
TYPE E-2 TRACK
KSS-5002
D
31 AUG 04


CONCRETE SURFACE AT TOP OF RAIL (T/R)
STEEPER SLOPE TO RETAIN 3" DEPRESSION IN FRONT OF STATION PLATFORM WALL
℄ TRACK
4'-6" TO FACE OF PLATFORM TACTILE STRIP
SURFACE SLOPE
DRAINAGE FLOW
RAISED CURB
T/R-3"
T/R-3"
T/R-3"
SIDE STATION PLATFORM
PLAN VIEW DRAINAGE DEFLECTION AT STATION AREAS
SCALE: 3/8"=1'-0"
℄ RIGHT TRACK
WALL OF STATION
9'-3" TRACK SLAB
4'-6"
4'-9"
TOP OF PLATFORM
PLATFORM EDGE TACTILE WARNING CUES RAISED TRUNCATED DOMES
4'-8 1/2" TRACK GAUGE
2 13/64"
6"
24"
STATION PLATFORM
COMPACTED AND PREPARED SUBGRADE
REINFORCEMENT
RI53N GIRDER RAIL IN RUBBER BOOT
EXPANSION BOARD
CONCRETE TRACK SLAB SINGLE POUR-13" HEIGHT
8" AGGREGATE BASE COURSE
DRAIN SLOPE AT PLATFORM WALL
SCALE: 3/4"=1'-0"
℄ RIGHT TRACK
0'-6" CURB
FOR CATCH BASIN DETAILS REFER TO DWGS KS3-5065 AND KS3-5070
10'-6" TRACK SLAB
4'-6"
6'-0"
FOR CURB DETAILS REFER TO DWG KS3-4100
ADJACENT ROADWAY SURFACE AT APPROXIMATE TOP OF RAIL ELEVATION
4'-8 1/2" TRACK GAUGE
2 13/64"
6"
3"
1'-0" MIN
COMPACTED AND PREPARED SUBGRADE
REINFORCEMENT
RI53N GIRDER RAIL IN RUBBER BOOT
EXPANSION BOARD
CONCRETE TRACK SLAB SINGLE POUR-13" HEIGHT
8" AGGREGATE BASE COURSE
STANDARD DRAIN SLOPE APPROACHING STATION PLATFORM
SCALE: 3/4"=1'-0"
REVISIONS
CONFORMED
PB PARSONS BRINCKERHOFF
31 AUG 04
Valley Metro RAIL
CENTRAL PHOENIX / EAST VALLEY LRT
TRACKWORK STANDARD
DRAINAGE DETAILS
NEAR STATION PLATFORMS
RI53N GIRDER RAIL
KS3-5055
0
542



CONFORMED

PB PARSONS BRINCKERHOFF

Valley Metro RAIL

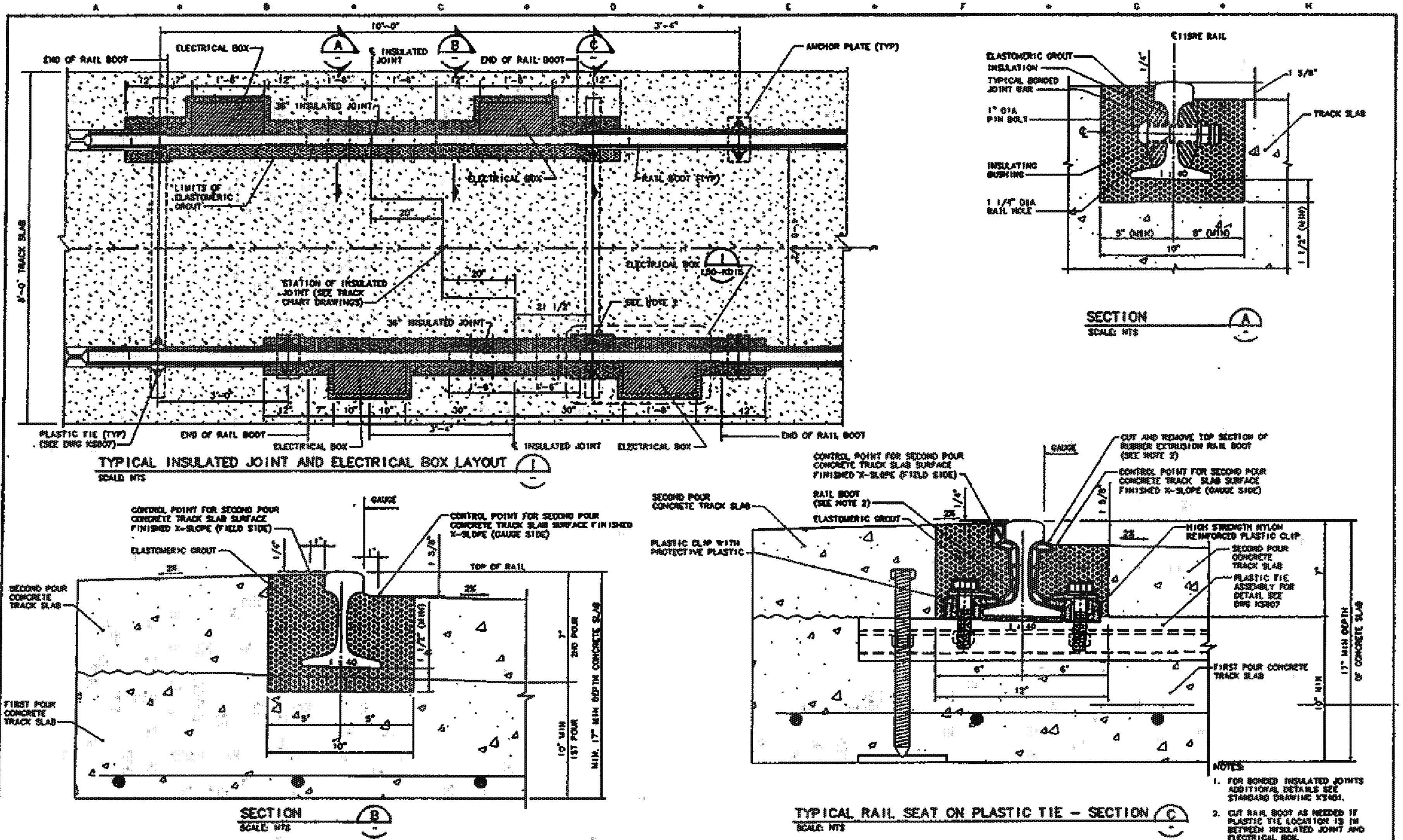
DESIGNED BY	B. CONDRON
DRAWN BY	B. CONDRON
CHECKED BY	C. MARTIN
APPROVED BY	S. BALL
SCALE	AS NOTED
DATE	31 AUG 04

CENTRAL PHOENIX / EAST VALLEY LRT
TRACKWORK STANDARD

TRANSVERSE TRACK DRAIN IN EMBEDDED DOUBLE TRACK AT MID BLOCK SECTIONS (RI53N GIRDER RAIL)

DRAWING NO.	KS5-5081
REVISION	0
CONTRACT NO.	LRT-04-029-LS1
SHEET NO.	344

AR00126957



No.	Date	Dsn.	Chk.	App.	Revisions
0	12/12/03				CONFORM

City of Seattle

Designed By: J. GACIARZ
Drawn By: J. GACIARZ
Checked By: L. GATLABAYAN
Approved By: L. CUSTETICH
Y1634

Submitted: J. HARRISON — Date: 12/12/03
Approved: T. RASEN — Date: 12/12/03

SOUND TRANSIT

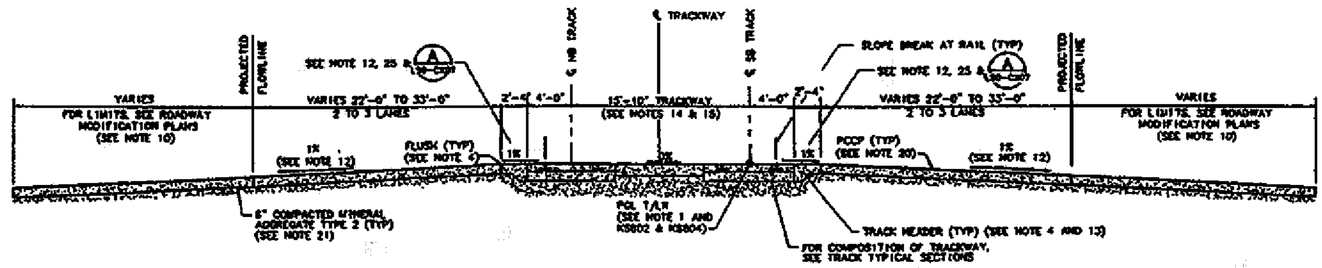
Scale: AS SHOWN
Filename: C40_L50_KD14.dwg
Contract No.: C 735
Date: 05/30/03

LINK LIGHT RAIL PROJECT
SOUTH CORRIDOR
EMBEDDED TRACK DETAIL
TYPICAL INSULATED JOINTS AND ELECTRICAL BOX LAYOUT

Drawing No.: L50-KD14
Vault Plan No.: 231-740
Sheet No.: 93A
Rev.: 0

343209

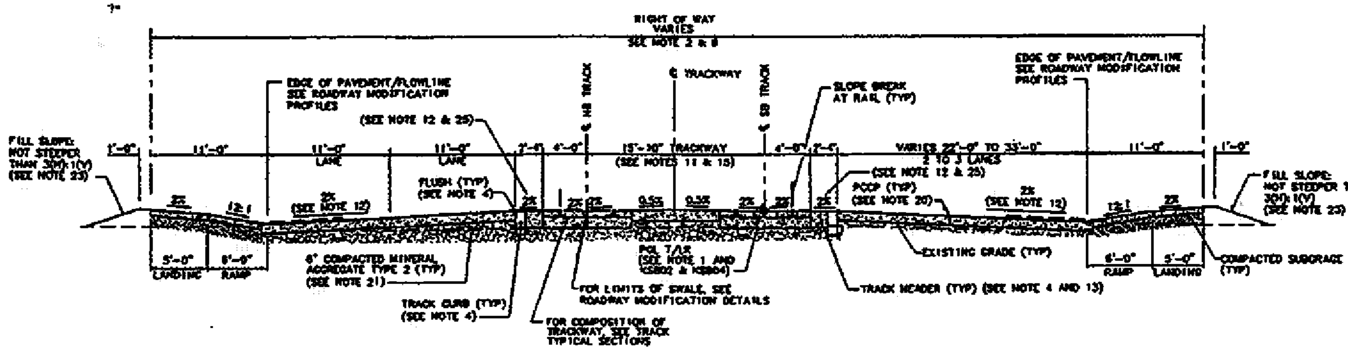
AR00126958



TYPICAL SECTION @ SIGNALIZED INTERSECTIONS

SCALE: NTS
MARTIN LUTHER KING JR. WAY S.
(END CURBING AND PAVEMENT WIDTHS ASSOCIATED WITH THE OTHELLO AND HENDERSON STATIONS ARE NOT REFLECTED IN THIS SECTION. SEE NOTE 7)

S. HOLLY ST:	SB 406+57.02 TO 407+65.43 RT, SB 406+71.87 TO 407+81.37 LT
S. MYRTLE ST:	SB 420+34.52 TO 421+44.02 RT, SB 420+49.64 TO 421+54.47 LT
S. OTHELLO ST:	SB 427+23.57 TO 428+48.10 RT, SB 427+34.93 TO 428+62.47 LT
S WEBSTER ST/RENTON AVE S:	SB 433+88.61 TO 434+85.98 RT, SB 433+45.08 TO 435+03.80 LT
S. KENYON ST:	SB 447+60.12 TO 448+65.78 RT, SB 447+73.12 TO 448+89.62 LT
S. CLOVERDALE ST:	SB 467+91.18 TO 469+01.66 RT, SB 468+07.83 TO 469+18.54 LT
S. HENDERSON ST:	SB 478+63.81 TO 479+79.81 RT, SB 478+54.32 TO 479+88.64 LT
MORTON WAY S:	SB 500+93.33 TO 502+68.17 RT, SB 500+99.46 TO 502+56.67 LT
S. NORFOLK ST:	SB 514+76.07 TO 515+98.68 RT, SB 514+81.84 TO 516+04.82 LT



TYPICAL SECTION @ SIGNALIZED PEDESTRIAN CROSSINGS

SCALE: NTS
MARTIN LUTHER KING JR. WAY S.

S. WILLOW ST:	SB 413+56.58 TO 413+69.12 RT, SB 413+71.53 TO 413+84.10 LT
S. HOLDEN ST:	SB 441+07.93 TO 441+19.93 RT, SB 441+13.81 TO 441+25.81 LT
S. ELMGROVE ST:	SB 454+40.14 TO 454+52.27 RT, SB 454+41.73 TO 454+53.92 LT
S. THISTLE ST:	SB 461+99.95 TO 462+12.71 RT, SB 462+18.63 TO 462+29.39 LT
S. TRENTON ST:	SB 474+99.61 TO 475+11.72 RT, SB 475+71.10 TO 475+83.04 LT (IN ADDITION, SEE WIDENED TRACK SECTION)

NOTES:

1. FOR PROFILES OF THE POL, SEE TRACK AND ROADWAY MODIFICATION PROFILES.
2. FOR LIMITS OF ROADWAY WIDENING, LIMITS OF EXISTING PAVEMENT, AND CURB & SIDEWALK MODIFICATIONS, SEE ROADWAY MODIFICATION PLANS.
3. FOR PAVEMENT MARKINGS AND SIGNING, SEE TRAFFIC PLANS.
4. FOR TRACK HEADER AND TRACK CURB TRANSITIONS, SEE ROADWAY MODIFICATION DETAILS.
5. SEE SYSTEMS PLANS AND TRACK TYPICAL SECTIONS FOR OCS POLE FOUNDATIONS AND DUCT BANK LOCATIONS.
6. FOR LOCATION AND LIMITS OF LANDSCAPE STRIP, SEE ROADWAY MODIFICATION PLANS AND DETAILS.
7. FOR STATION PLATFORM AND RAMP CONFIGURATION, SEE ARCHITECTURAL SHEETS.
8. FOR LIMITS OF PROPOSED RIGHT OF WAY, SEE RIGHT OF WAY PLANS.
9. FOR LOCATION OF ALTERNATIVE SIDEWALK SECTIONS, SEE ROADWAY MODIFICATION PLANS.
10. FOR INTERSECTION ELEVATIONS, SEE INTERSECTION GRADING PLANS AND CROSS STREET PROFILES.
11. FOR PCC PAVEMENT JOINTS AND TYPICAL LAYOUT, SEE ROADWAY MODIFICATION DETAILS.
12. FOR CROSS SLOPE TRANSITIONS, SEE ROADWAY MODIFICATION PROFILES.
13. FOR VARIATIONS IN TRACK HEADER AND CURB WIDTH SEE TRACK HEADER WIDTH TABLE, DRAWING L45-CX01. FOR BEGIN/END TRANSITION STATIONS, SEE ROADWAY MODIFICATIONS PLANS.
14. THE CIRCULAR PORTION OF ALL SPIRALED CURVES HAVE A 16'-0" TRACK CENTER. SIMPLE CURVES AND TANGENTS MAINTAIN THE 15'-10" TRACK CENTER.
15. FOR TYPE AND LOCATION OF PEDESTRIAN ISLANDS, SEE ROADWAY MODIFICATION PLANS.
16. NORTHBOUND AND SOUTHBOUND ALIGNMENTS FOLLOW INDEPENDENT PROFILES IN SOME LOCATIONS. FOR STATION LIMITS, SEE TRACK PLAN AND PROFILES.
17. FOR SIDEWALK DETAILS, SEE SEATTLE STANDARD PLAN NO. 420.
18. FOR CURB DETAILS, SEE SEATTLE STANDARD PLAN NO. A10.
19. FOR LOCATIONS OF ASPHALT CONCRETE SIDEWALK, SEE ROADWAY MODIFICATION PLANS.
20. FOR PORTLAND CEMENT CONCRETE PAVEMENT DETAILS, SEE ROADWAY MODIFICATION DETAILS AND SEATTLE STANDARD PLAN NO. 401, 402, AND 405.

    MLK JR WAY S PORTLAND CEMENT CONCRETE PAVEMENT DEPTHS (INCLUDING ACP CROSS STREETS THROUGH CURB RETURNS)
    - PCCP-11" 280+00 TO 380+00
    - PCCP-12" 380+00 TO 392+89
21. MINERAL AGGREGATE TYPE 2 WILL BE ACCORDING TO SEATTLE STANDARD SPECIFICATIONS SECTION 9-03.9(3).
22. FOR WIDTHS AND LOCATIONS OF CROSS STREET SIDEWALK/LANDSCAPE STRIP, SEE ROADWAY MODIFICATION PLANS.
23. EXCEPTIONS TO THE 3:1 CUT/FILL SLOPE ARE SHOWN IN THE PROPERTY CONFORM TABLE.
24. FOR LOCATION AND LIMITS OF LANDSCAPE IN GORE AREA SEE ROADWAY MODIFICATION PLANS AND LANDSCAPE PLANS.
25. CROSS SLOPE OF TRACK HEADER AND GORE AREA TO MATCH ROADWAY CROSS SLOPE UNLESS OTHERWISE NOTED ON ROADWAY MODIFICATION PROFILES AND DETAILS. FOR ADDITIONAL DETAILS ON TRACK HEADER SLOPE SEE DETAILS A & B ON L50-CX07.

No.	Date	Revisions
A	[illegible]	ISSUED FOR CONSTRUCTION-CONFORM
1	[illegible]	CHRFP #179
0	12/12/03	CONFORM

City of Seattle

Designed By: J. BLAND
Drawn By: J. DANIELSON
Checked By: T. LA
Approved By: B. SHINN

CH2MHILL

SOUND TRANSIT

Submitted: S. KAMBOL Date: 12/12/03
Approved: T. RABEN Date: 12/12/03

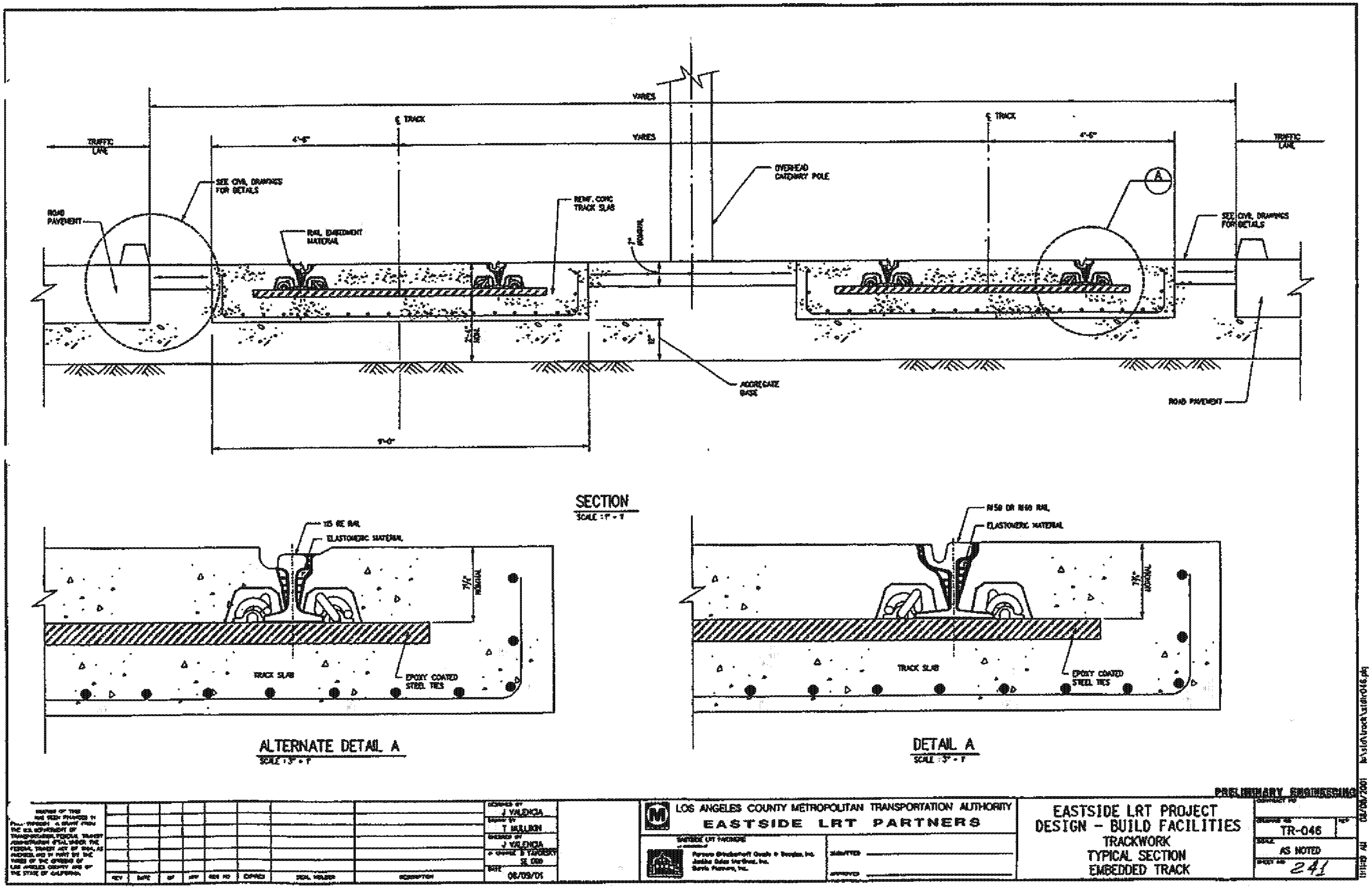
Scale: AS SHOWN
Filename: C40_L50_CX03.dwg
Contract No: C 735
Date: 05/30/03

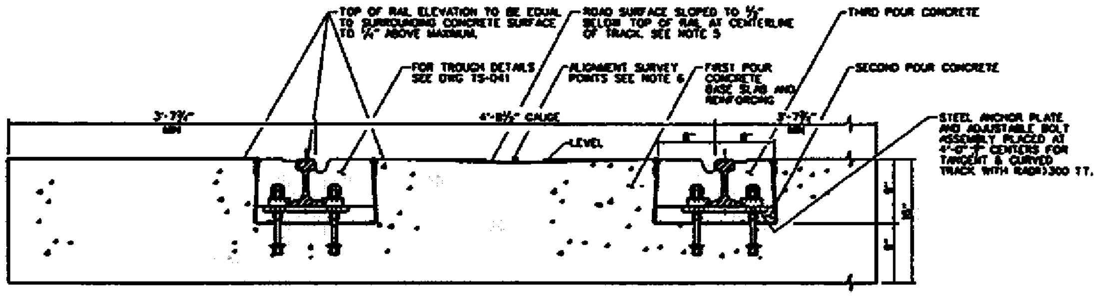
LINK LIGHT RAIL PROJECT
SOUTH CORRIDOR

TYPICAL ROADWAY SECTIONS

Drawing No.: L50-CX03
Vault Plan No.: 231-740
Sheet No.: 180 Rev: A

34209

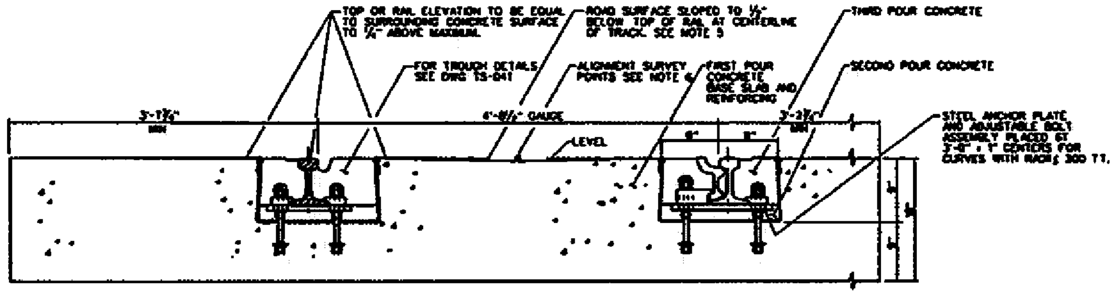

TRAFFIC LANE
ROAD PAVEMENT
SEE CIVIL DRAWINGS FOR DETAILS
VARIES
℄ TRACK
4'-8"
RAIL EMBEDMENT MATERIAL
REINF. CONC TRACK SLAB
OVERHEAD CATENARY POLE
AGGREGATE BASE
9'-0"
SECTION
SCALE 1" = 1'
115 RE RAIL
ELASTOMERIC MATERIAL
TRACK SLAB
EPOXY COATED STEEL TIES
ALTERNATE DETAIL A
SCALE 3" = 1'
RI59 OR RI60 RAIL
DETAIL A
SCALE 3" = 1'
PRELIMINARY ENGINEERING
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY
EASTSIDE LRT PARTNERS
EASTSIDE LRT PROJECT
DESIGN - BUILD FACILITIES
TRACKWORK
TYPICAL SECTION
EMBEDDED TRACK
TR-046
AS NOTED
241
J VALENCIA
T MULLIKIN
08/09/01



EMBEDDED TRACK CONCRETE SURFACE SECTION – TANGENT & CURVED TRACK

TYPE I

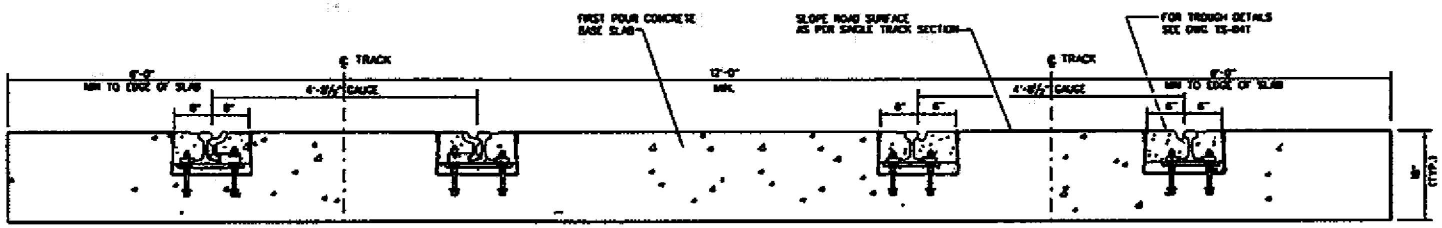
SCALE: 1/2" = 1'-0"



EMBEDDED TRACK CONCRETE SURFACE SECTION – CURVED TRACK

TYPE II

SCALE: 1/2" = 1'-0"



EMBEDDED TRACK CONCRETE SURFACE – DOUBLE TRACK MAINLINE SECTION

SCALE: 1" = 1'-0"

NOTES:

1. THIS DRAWING ILLUSTRATES THE CONCRETE SURFACE ROADWAY DETAIL. FOR COBBLE STONE OR PAVER BLOCK SYSTEMS REFER TO DWG. TS-040.
2. INSULATING MEMBRANE LINING MUST NOT BE PUNCTURED OR CRACKED DURING TRACK INSTALLATION. PUNCTURES AND CRACKS MUST BE REPAIRED TO PROVIDE CONTINUOUS INSULATING BARRIER.
3. JOINTS IN INSULATING MEMBRANE SHALL BE SEALED ACCORDING TO MANUFACTURER INSTRUCTIONS TO PROVIDE CONTINUOUS INSULATING BARRIER.
4. FOR DETAILS PERTAINING TO ENDS OF EMBEDDED TRACK REFER TO DWG. TS-050 TRANSITION SECTION EMBEDDED TRACK TO BALLASTED TRACK.
5. CONCRETE SURFACE BETWEEN RAILS SHALL BE:
   - LEVEL AT ALL CROSS STREET LOCATIONS.
   - SLOPED AS SHOWN AT ALL OTHER EMBEDDED AREAS.
6. BOTH TRACKS SHALL HAVE CENTERLINE SURVEYED AND MARKED, 10 FOOT ON TANGENTS AND 5 FOOT ON CURVED TRACK TO ESTABLISH HORIZONTAL AND VERTICAL ALIGNMENT. SURVEY MARK SHALL BE EMBEDDED NAIL OR PERMANENT FIXTURE. ELEVATION TO BE DOCUMENTED AND CONSTRUCTION PROFILE GRADELINE CUT LINE SHEETS PRODUCED TO SET TOP OF RAIL.
7. FOR INSTALLATION PROCEDURES REFER TO INSTRUCTIONS ON DWG. TS-045.
8. FOR MAXIMUM RAIL TOLERANCED POSITIONS WITHIN CONCRETE TROUGH SEE DWG. TS-048.
9. ADJUSTABLE RAIL MOUNTING PLATE AND ANCHOR BOLTS TO BE INSTALLED AT 3 OR 4 FOOT CENTERS OR LESS AT HORIZONTAL OR VERTICAL CURVE AREAS TO ACHIEVE PRECISE RAIL POSITION.

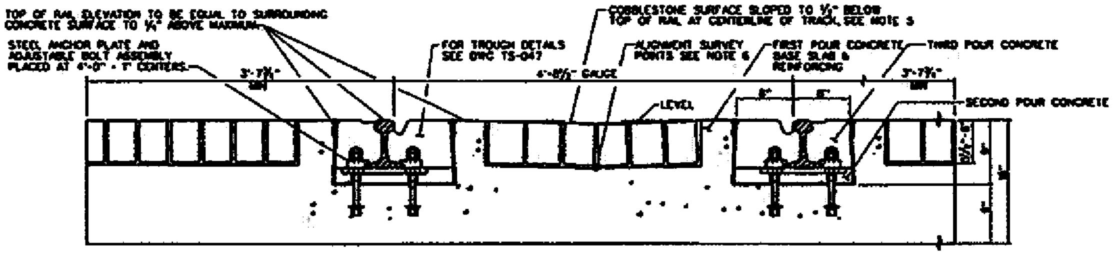
NJ TRANSIT

PB PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.
Two Gateway Center, 18th Fl.
Newark, N.J. 07102

HUDSON – BERGEN LIGHT RAIL TRANSIT SYSTEM

TRACKWORK STANDARD
EMBEDDED TANGENT/CURVED TRACK CONCRETE SURFACE SECTIONS AND CONCRETE ROADWAY TYPES I & II

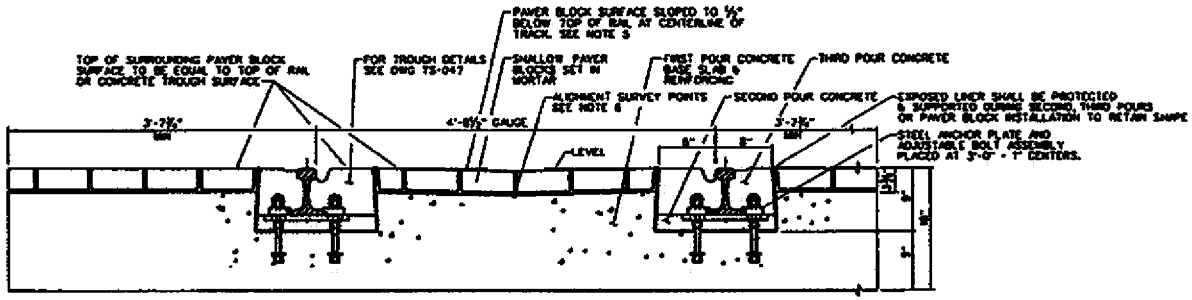
SCALE: AS SHOWN
DRAWING NO.: TS-040A
CONTRACT No.: 96CT001
ISSUE: CONTRACT



EMBEDDED TRACK - DEEP COBBLESTONE SECTION

TYPE III

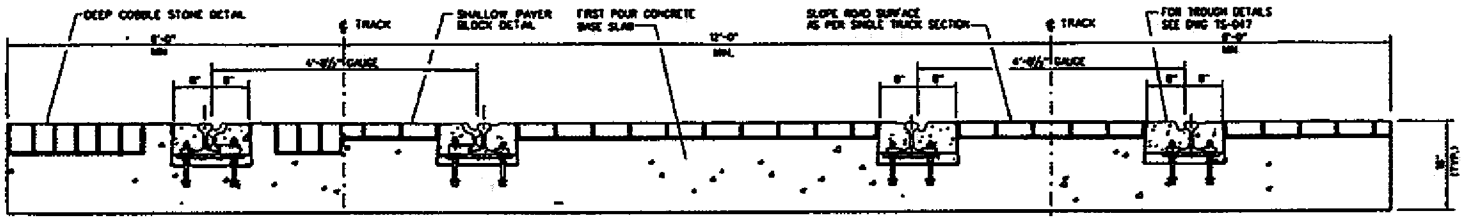
SCALE: 1 1/2" = 1'-0"



EMBEDDED TRACK - SHALLOW PAVER BLOCK SECTION

TYPE IV

SCALE: 1 1/2" = 1'-0"



EMBEDDED TRACK STONE/BLOCK SURFACE - DOUBLE TRACK MAINLINE SECTION

SCALE: 1" = 1'-0"

NOTES:

1. THIS DRAWING ILLUSTRATES THE DEEP & SHALLOW STONE OR BLOCK ROADWAY DETAIL. FOR SURFACE DETAILS SEE ARCHITECTURAL & STRUCTURAL DRAWINGS. FOR CONCRETE SURFACE ROAD REFER TO DWG. TS-040.
2. INSULATING MEMBRANE LINING MUST NOT BE PUNCTURED OR CRACKED DURING TRACK INSTALLATION. PUNCTURES AND CRACKS MUST BE REPAIRED TO PROVIDE CONTINUOUS INSULATING BARRIER.
3. JOINTS IN INSULATING MEMBRANE SHALL BE SEALED ACCORDING TO MANUFACTURER INSTRUCTIONS TO PROVIDE CONTINUOUS INSULATING BARRIER.
4. FOR DETAILS PERTAINING TO ENDS OF EMBEDDED TRACK REFER TO DWG. TS-050 TRANSITION SECTION EMBEDDED TRACK TO BALLASTED TRACK.
5. STONE/BLOCK SURFACE BETWEEN RAILS SHALL BE:
   - LEVEL AT ALL CROSS STREET LOCATIONS.
   - SLOPED AS SHOWN AT ALL OTHER EMBEDDED AREAS.

6.A BOTH TRACKS SHALL HAVE CENTERLINE SURVEYED AND MARKED, 10 FOOT ON TANGENTS AND 5 FOOT ON CURVED TRACK TO ESTABLISH HORIZONTAL ALIGNMENT. SURVEY MARK SHALL BE EMBEDDED NAIL OR PERMANENT FIXTURE.

6B. BOTH TRACKS SHALL HAVE TOP OF TROUGH EDGES SURVEYED 10 FOOT ON TANGENTS AND 5 FOOT ON CURVED TRACK TO ESTABLISH VERTICAL ALIGNMENT. ELEVATION TO BE DOCUMENTED AND CONSTRUCTION PROFILE GRADELINE CUT LINE SHEETS PRODUCED TO SET TOP OF RAIL.

7. FOR INSTALLATION PROCEDURES REFER TO INSTRUCTIONS ON DWG. TS-045.
8. FOR MAXIMUM RAIL TOLERANCED POSITIONS WITHIN CONCRETE TROUGH SEE DWG. TS-046.
9. ADJUSTABLE RAIL MOUNTING PLATE AND ANCHOR BOLTS TO BE INSTALLED AT 3 OR 4 FOOT CENTERS OR LESS AT HORIZONTAL OR VERTICAL CURVE AREAS TO ACHIEVE PRECISE RAIL POSITION.

NJ TRANSIT

PB PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC. Two Gateway Center, 15th Fl. Newark, N.J. 07102

G.V. MARTIN
T.Z. LOOS
L.R. PADGETT
H.L. BERLINER

HUDSON - BERGEN LIGHT RAIL TRANSIT SYSTEM

TRACKWORK STANDARD
EMBEDDED TRACK
DEEP & SHALLOW STONE/BLOCK SURFACE SECTIONS
TYPES III & IV

AS SHOWN
TS-046A
CONTRACT No. 96CT001
CONTRACT
of 849

Figure 1a: Portland Streetcar (approx 66 ft. long)

Figure 1b: Portland MAX LRT System - 2 Car Consist (approx 180 ft. long)

Figure 2: LRT Excavation for Power Distribution

Excavation below track slab and subbase required for power distribution lines.
After power distribution is complete and back filled, subbase & track slab can be constructed.

Figure 3: LRT Excavation for Power Distribution

Excavation below track slab and subbase required for power distribution lines.
After power distribution is complete and back filled, subbase & track slab can be constructed.

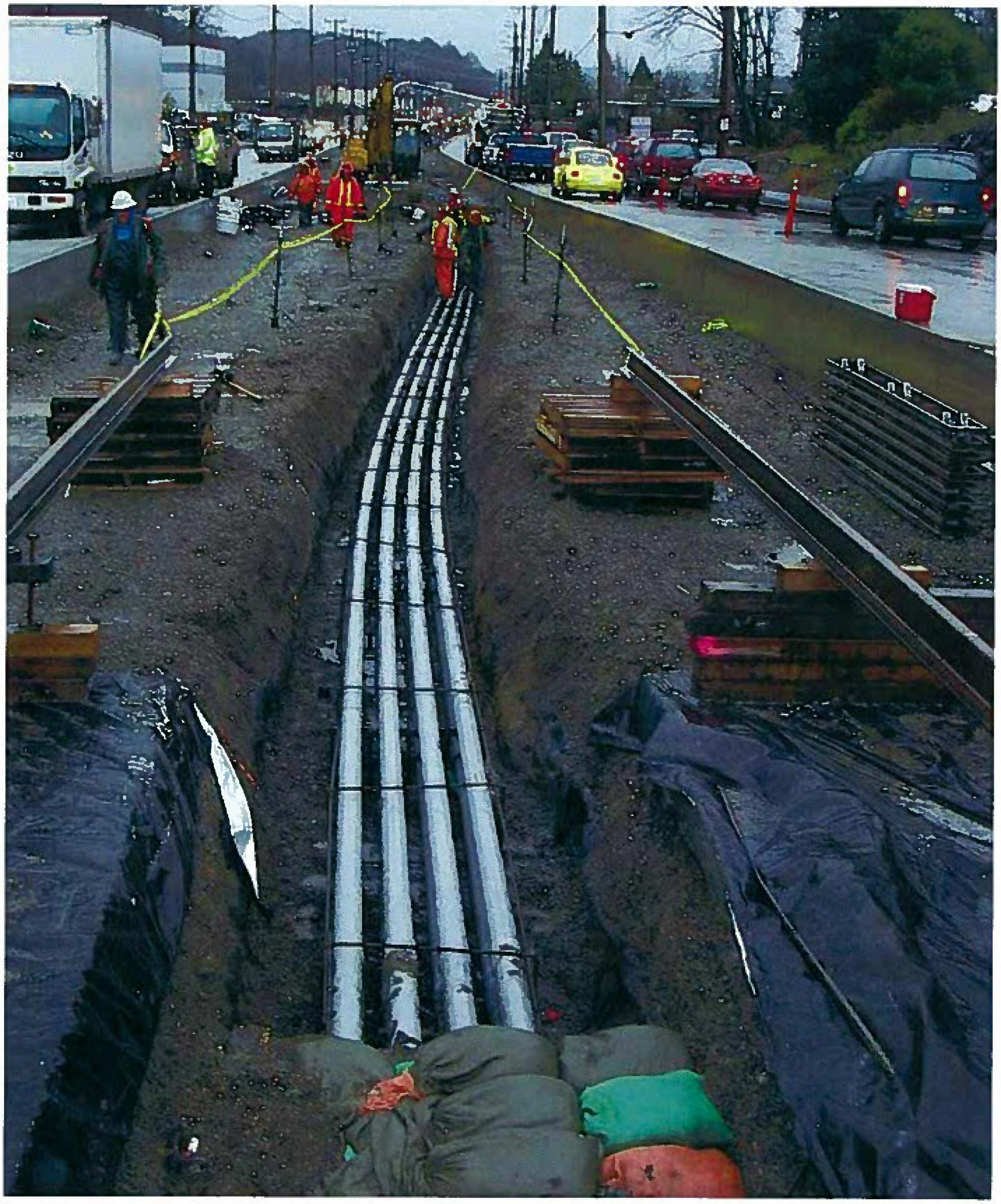


Figure 4: LRT Excavation for Power Distribution

Excavation below track slab and subbase required for power distribution lines.
After power distribution is complete and back filled, subbase & track slab can be constructed.

Figure 5: **LRT Utility Relocation Trench Excavation**
Excavation required to relocate utilities from below track slab.

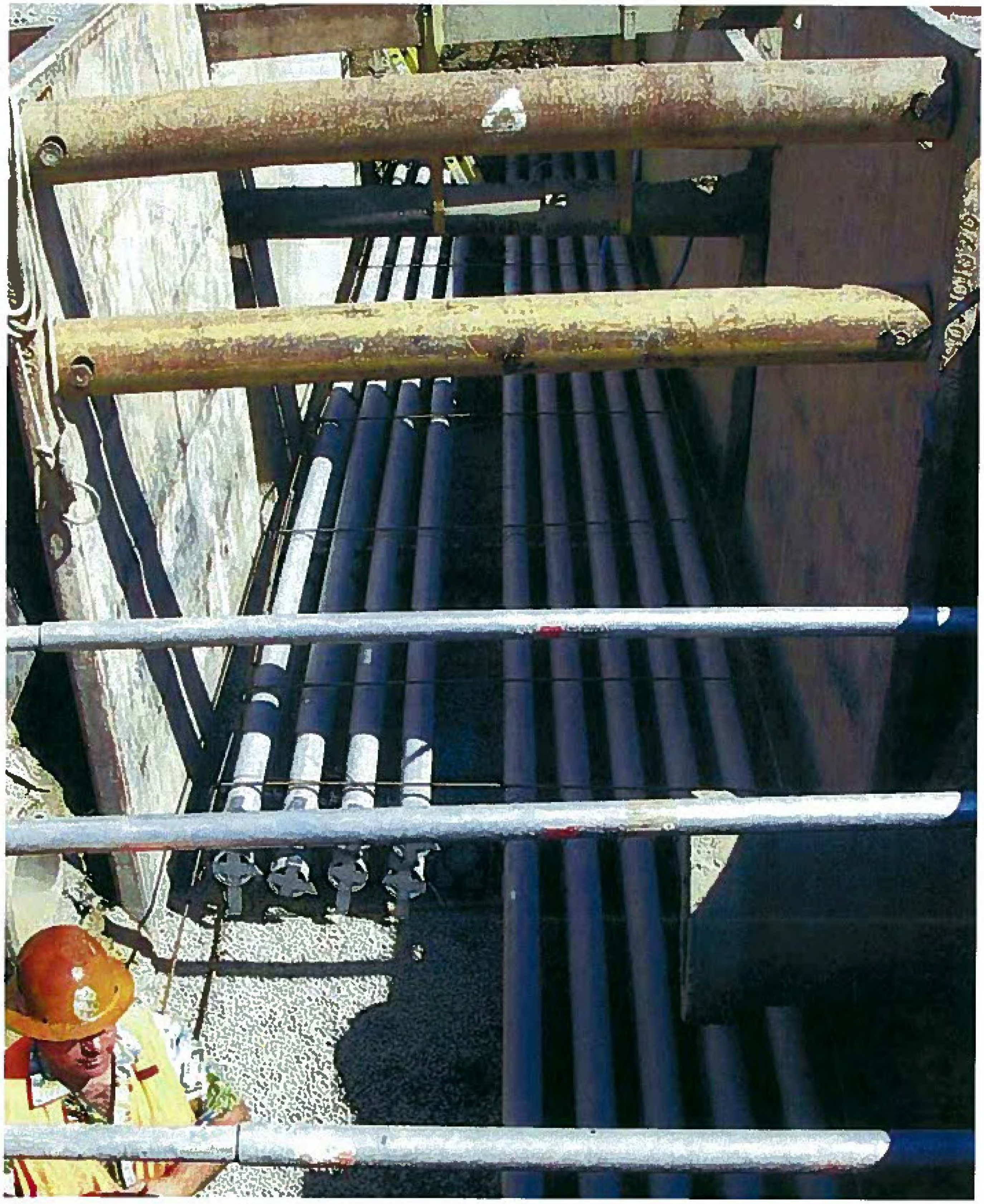


Figure 6: LRT Utility Relocation Trench Excavation
Excavation required to relocate utilities from below track slab.

Figure 7: LRT Track Slab Reinforcement

Track slab subbase & reinforcement placed after power distribution installation is complete.

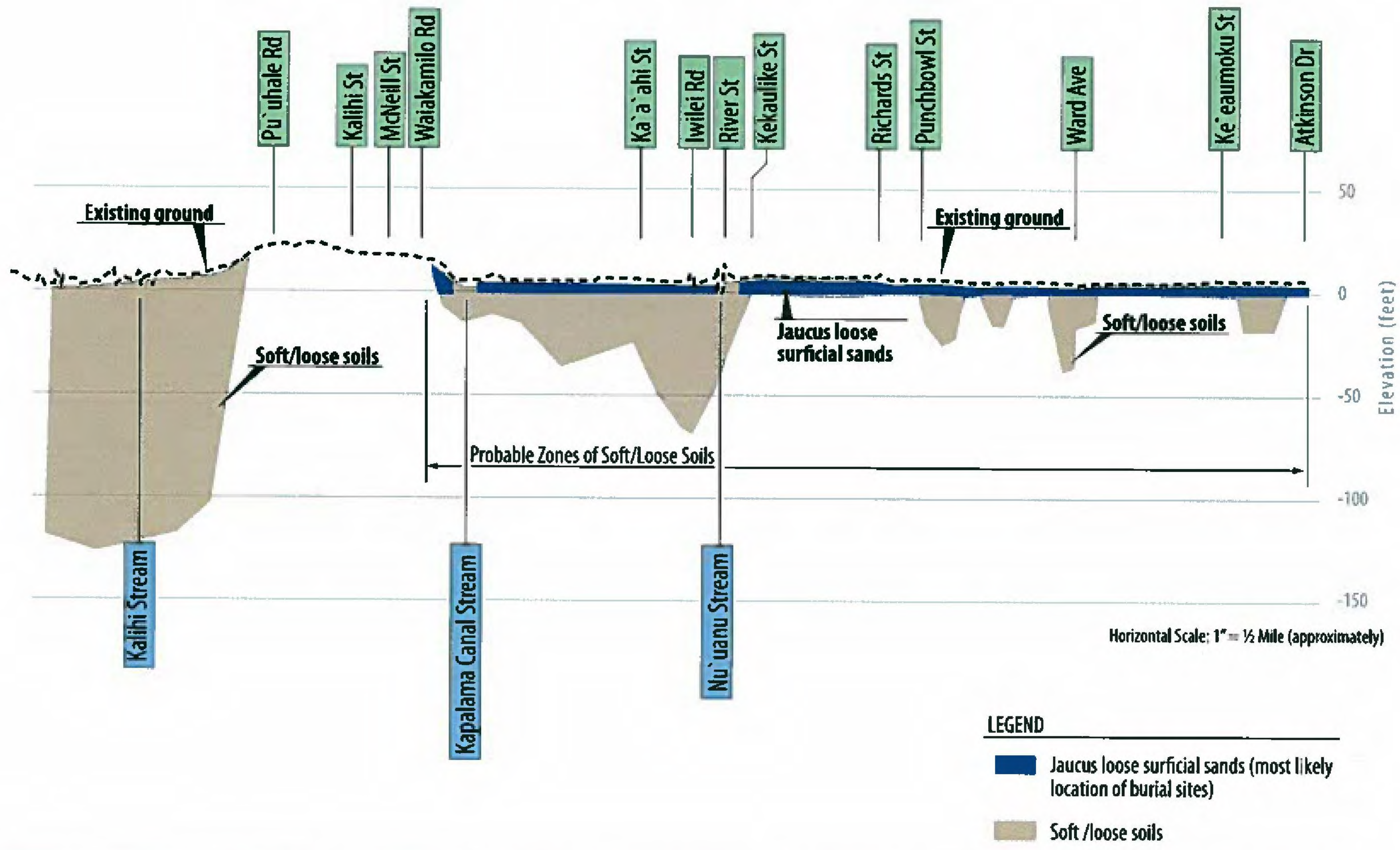
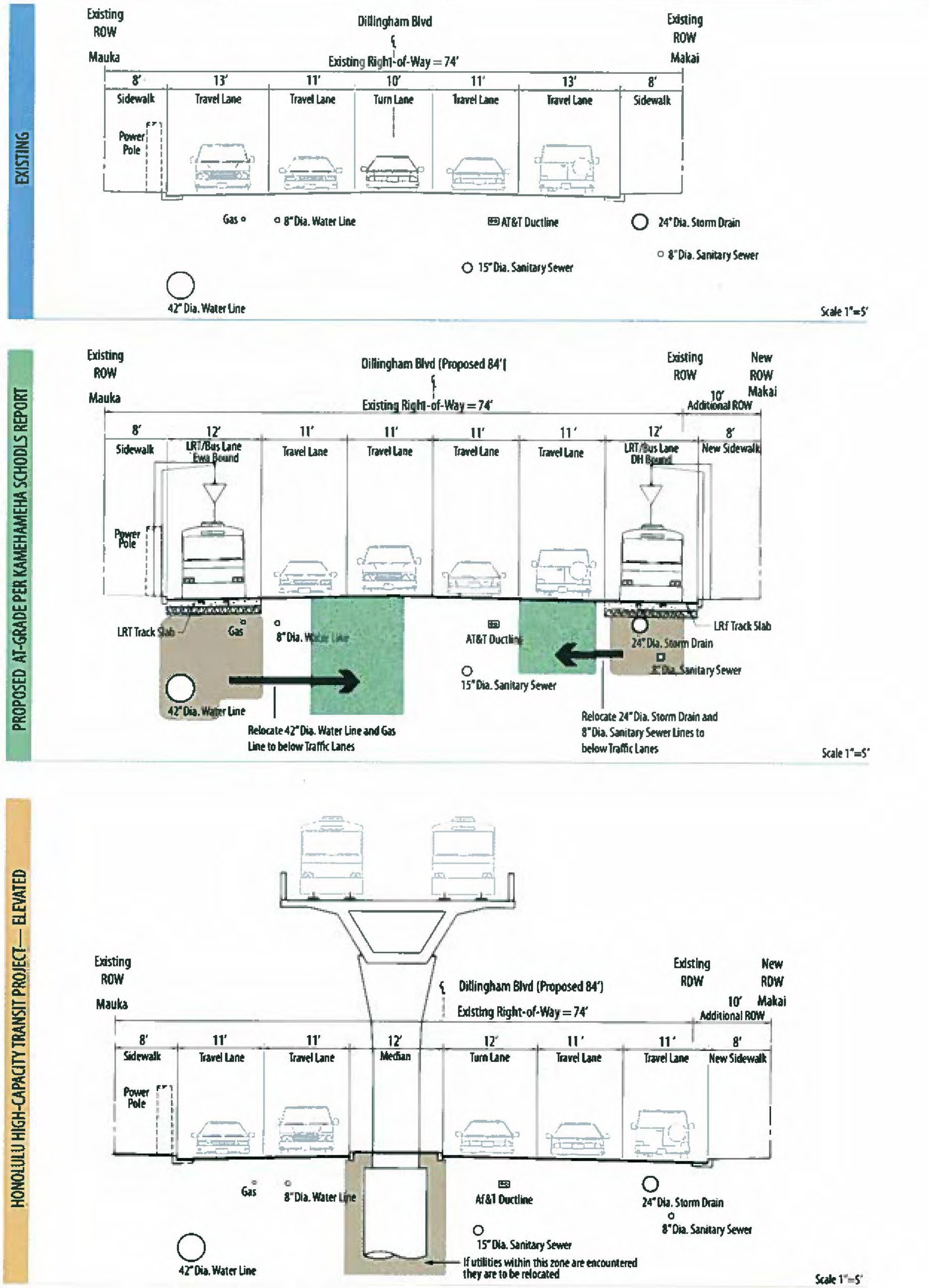


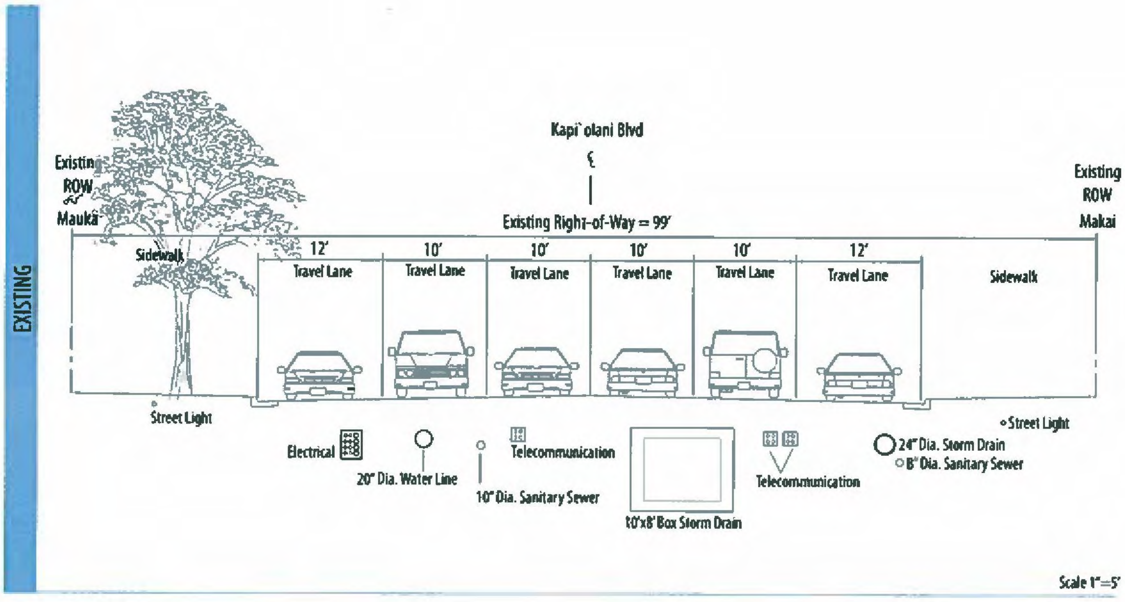
Figure 8: Approximate Locations of Soft or Loose Soils Below Proposed At-Grade LRT Alignment Described in Kamehameha Schools Report

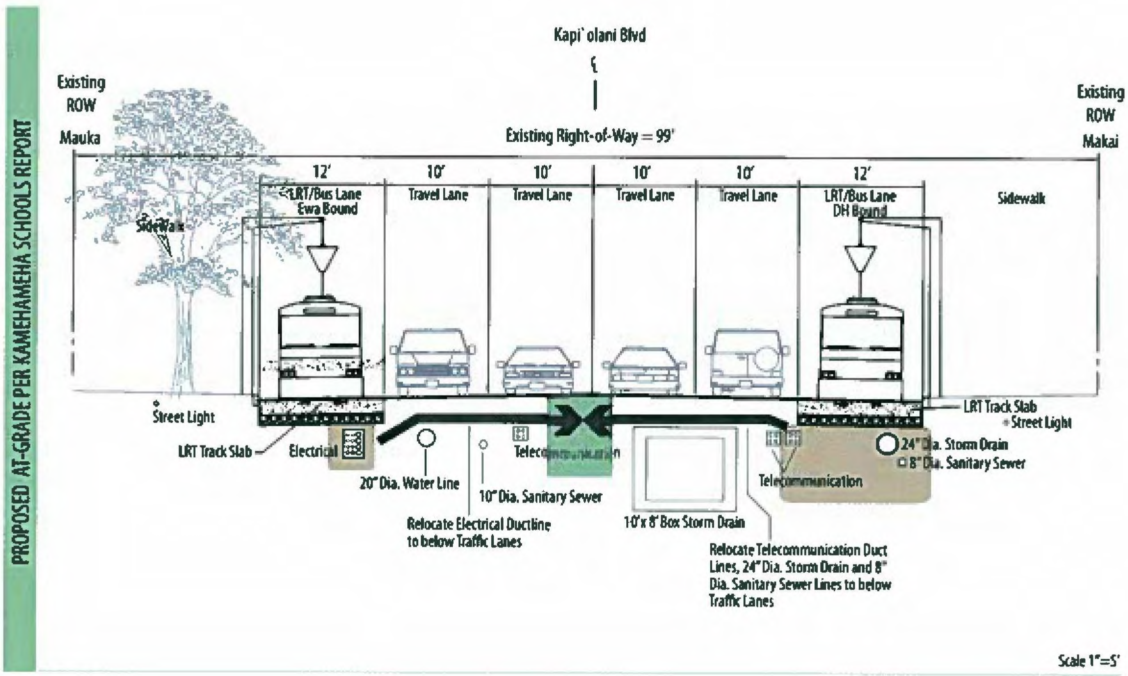


LEGEND

- Zones of existing utilities impacted
- Utilities relocated to these areas

Figure 9: Dillingham Boulevard (Middle Street to Iwilei Road) Cross-Sections





LEGEND

- Zones of existing utilities impacted
- Utilities relocated to these areas

Figure 10: Kapi'olani Boulevard Cross-Sections